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**Epidemiology of Frailty in Older People**

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**Abstract**

Frailty is a complex of symptoms that is characterized by impaired stress tolerance due to a decline in the functionality of different organs. Due to its multifactorial aetiology, several definitions and assessments of this symptom complex have been developed, of which the Fried Frailty Score (Phenotype Score) and the broader Frailty Index (Deficit Accumulation Index) are the most commonly used. The prevalence of frailty increases with age independently of the assessment instrument and ranges between 4% and 59% in community-dwelling elderly populations and is higher in women than in men. The actual prevalence rate in a population depends on the prevalence of chronic diseases including depression, nutritional status, and inherently socio-economic background and education. Frailty is, however, not a steady state and progression, but also reversion is common. Although numerous studies on the prevalence of frailty have been conducted, systematic assessments in different populations are rare, which reduces the comparability of results. Similarly heterogeneous, but less frequent are studies on the incidence and on trajectories and transitions of frailty, calling for further, more systematic studies on this topic.

Frailty is a complex of symptoms that is characterized by impaired stress tolerance due to a decline in the functionality of different organs because of sarcopenia, nutritional deficiencies, hormonal changes, and increased inflammation (1, 2). Though not a disease in itself, it is associated with an increased risk of falls, disability, hospitalization, institutionalization, and finally mortality (2, 3).

There is no uniform definition of the frailty symptom complex. However, most studies are based on the definition introduced by Fried and colleagues (2), which includes unintentional weight loss, self-reported exhaustion, poor grip strength, slow walking speed, or low physical activity (2). This model is also called the Phenotype Model (4). Individuals are usually considered as frail if they meet at least 3 of the 5 criteria and as prefrail if they meet 1 or 2 of these criteria. This definition has a focus on the physical aspects of frailty. A more complex score, the so-called Frailty Index (or Frailty Index of Deficit Accumulation), was established by Mitnitski and colleagues (5) based on the proportion of 20 deficits observed in a structured clinical examination. These deficits include diseases, signs, symptoms, laboratory abnormalities, cognitive impairments, and disabilities in activities of daily living (6). Other definitions exist, but these two, the Fried Frailty Score and the Frailty Index, are most frequently used in studies.

**Prevalence**

The prevalence of frailty has been assessed in many studies worldwide, although most studies were conducted in Western countries.

One of the most comprehensive reviews on the epidemiology of frailty included 21 community-based studies with 61,500 persons 65+ years old (7). Overall, the prevalence of frailty varied from 4.0% to 59.1% with an overall weighted prevalence of frailty of 10.7% (95% confidence interval (CI) 10.5-10.9). Of the 21 studies included, 14 used the Fried Frailty Score (2). A difference in the prevalence of frailty between studies emerged when studies were stratified by the assessment for frailty (7). In studies that assessed physical frailty, using e. g. the Fried Frailty Score, the prevalence rate ranged between 4.0% and 17.0%, but between 4.2% and 59.1% in studies that used broad definitions or measurement instruments (covering physical, but also social and psychological aspects for frailty). The weighted prevalence rate

was 9.9% for physical frailty (95% CI 9.6-10.2; based on 15 studies with 44,894 participants) and 13.6% for the broad phenotype of frailty (95% CI 13.2-14.0; based on 8 studies with 24,072 participants).

Another review explicitly included only studies that used the Fried Frailty Score to assess the prevalence of frailty in community-dwelling individuals 65 years of age and older (8). In the six studies included, the prevalence of frailty ranged between 4.9% in Taiwan and 27.3% in Spain. The Survey of Health, Aging and Retirement in Europe (SHARE; (9)) assessed frailty in a uniform way in Europe and still yielded vastly different prevalence rates across Europe. Generally, they observed a prevalence of 17%, with lows of 5.8% in Switzerland and 8.6% in Sweden and a high prevalence rate of 23% in Italy and 27.3% in Spain. The prevalence rates of prefrailty were more comparable between the single countries with 46.5% in Switzerland, 45.3% in Sweden, 43.6% in Italy, and 50.9% in Spain.

Geographic variation

There is some indication that the prevalence of frailty and the extent of frailty is higher in poorer than in countries that are more affluent. A secondary analysis of the SHARE survey, which included more than 35,000 participants at least 50 years old from 15 countries, observed a lower mean frailty index in higher-income countries than in lower-income countries (10). The overall mean frailty index was inversely correlated with both gross domestic product ($r = -0.79$; $P < 0.01$) and health expenditure ($r = -0.63$; $P < 0.05$). The prevalence of frailty was lower in higher-income countries compared with lower-income countries (16.1 versus 27.6%; $P < 0.01$). Interestingly, survival in non-frail participants 2 years after baseline assessment was not associated with national income, but survival in frail people was significantly better in higher-income countries (10). One explanation for the higher prevalence of frailty in Southern compared with Northern countries participating in the SHARE study might be the lower rates of institutionalization of older disabled persons in southern countries, leading to a higher prevalence of frailty in community-based studies.

In a systematic review of 47 studies that included community-dwelling adults 60+ years old in low- and middle-income countries, the pooled prevalence rate of frailty was 17.4% (95% CI 14.4%-20.7%) (11).This is higher than the overall weighted prevalence of frailty of 10.7% (95% CI 10.5-10.9) in 21 studies from high-income countries (7). The prevalence rates of frailty varied between 3.9% in China and

51.4% in Cuba; the prevalence of prefrailty ranged from 13.4% in Tanzania to 71.6% in Brazil (11). However, only one low-income country (Tanzania) and one low-middle income country were included in that analysis; all other studies were conducted in high-middle income countries. The prevalence prefrailty was 49.3% (95% CI 46.4%-52.2%) in low- and middle-income countries (11), which was also higher than the pooled rate of 41.6% (95% CI 41.2%-42.0%) in high-income countries (7).

It is interesting to note that even studies conducted in the same country do not always provide similar estimates. The FRALLE survey, conducted in the Spanish city of Lleida, reported a frailty prevalence of 9.6% in participants 75+ years old (5.2% in men and 12.5% in women; (12)), but other Spanish studies provided prevalence rates ranging from 10.3% to 20.1% (see (12)). In the US, the prevalence reported was also very disparate, ranging from 6.9% in the study by Fried et al. (2001) to 19.5% in the study among Mexican-Americans (13). A study looking at racial differences in the US observed that 8.7% of African-American men and 15.0% of African-American women were frail compared with 4.6% and 6.8% of white men and women, respectively (14). In adjusted models, taking age, sex, comorbidity, and socioeconomic factors into account, non-obese African Americans had fourfold greater odds of frailty compared with whites. This study also noted that the increased odds of frailty associated with African-American race was less pronounced among those who were obese or disabled. This study shows that, although socio-economic factor might play an important role, there may be other factors that play a role in the development of frailty. Large ranges were also reported from LMIC. A systematic review reported that the prevalence rate of frailty in community-dwelling older people ranged between 17% and 31% in Brazil, between 5% and 31% in China, and from 21% to 44% in Russia, with all studies using the Fried Frailty Score (15).
A Chinese study that included individuals of 60+ years used the physical frailty phenotype scale and reported a frailty prevalence of 7%, which ranged between 3.3% and 9.1% depending on the study region (16). It was higher in rural than in urban areas and, as other studies had shown before, frail individuals were more likely to have co-morbidities and functional limitations than non-frail individuals were.

**Incidence**

Incidence studies on frailty are rare; most studies only describe the prevalence in a certain population. In the Cardiovascular Health Study, which included 5,317 participants 65 years and older, the four-year incidence was 7.4% (2). In an analysis of the longitudinal Osteoarthritis Initiative (OAI) database with 4421 study participants, the incidence of frailty amounted to 12 (95% CI 10–14) participants per 1000 person-years (17). In an analysis of the *Progetto Veneto Anziani*, which included 1887 individuals older than 65 years of age and free of frailty at baseline, 21.9% had become frail after an observation period of 4.4 years (18). These results illustrate the problems with respect to information on frailty incidence from longitudinal studies. Even if numbers of incident frailty cases are reported, it is difficult to compute incidence rates due to the lack of information on person-time. Moreover, hardly any study used age-standardization to make studies comparable. This was illustrated in a systematic review by Galluzzo et al. (19). Only 3 of the 6 studies included had the aim of estimating frailty incidence, with a wide age-range of participants. The incidence proportion ranged from 5% (follow-up 22.2 years; age ≥ 30 years) to 13% (follow-up 1 year, age ≥ 55 years). Looking only at studies that used the Fried Frailty Score and were conducted on relatively similar samples in terms of age, the incidence proportions ranged from 3.9% for a follow-up of about 3 years to about 8% over periods from 3.5 to 9.9 years. The highest incidence rate was observed in an Australian study that included remotely living aboriginal people. Participants were 45+ years old, and of those who were non-frail at the beginning of the study, 51.5% became frail during the 7-year follow-up period (20).

## Reasons for differences in the prevalence of frailty between populations

### Differences due to different assessment instruments

The definition of frailty varies from physical disability, impairment in basic or instrumental activities of daily living to an increased vulnerability to adverse outcomes. In a review, Buta et al. identified 67 frailty instruments that were mentioned in scientific publication, of which nine were highly-cited (≥200 citations) (21). The Physical Frailty Phenotype, as introduced by Fried et al., was the most frequently used frailty instrument in the research literature, followed by the Deficit Accumulation Index and the Vulnerable Elders Survey. The definition by Fried et al. focuses on a wasting syndrome, with weight loss and negative energy balance as

important elements (2). Other criteria have emphasized a life course approach, taking into account mid- and early-life influences on late-life frailty. Cognitive and social factors for improving the prediction of frailty are a more-recent research focus (21). For example, a US study among 6000 community-dwelling elderly adults (65-95 years old) showed that including cognitive impairment as a variable improved the predictive validity of the operational definition of frailty (22). Another study conducted among 744 70+ year old community-dwelling individuals concluded that slow gait speed, low physical activity, weight loss, and cognitive impairment were key indicators of frailty, but questioned the usefulness of self-reported exhaustion and muscle weakness (23).

Collard et al. (7) showed in their meta-analysis that the differences in frailty prevalence rates were less diverse when assessments based on the physical frailty definition were used compared with a broader definition that also covers social and psychosocial aspects. The smaller range of frailty rates in the first group of studies might imply more consensus in the definition of frailty between researchers or a more reliable definition. The advantage is a better comparability of studies. If a broad frailty definition is used, it appears to be very important to examine separately the different aspects within the respective frailty definition. This will provide more information about who needs special care in specific domains, but may also enhance the understanding and disentangling of underlying pathophysiological processes of frailty.

Differences due to different operationalizations of the single components of the instrument

The Fried Frailty Score basically assesses slow walking, weak grip strength, low physical activity, exhaustion, and weight loss (2). However, depending on the concrete assessment of these five variables, the prevalence rate might differ even though the same definition has been used. This has been studied and discussed in the SHARE study. Criteria used to define frailty in the SHARE study were not identical to those used in the Cardiovascular Health Study, except for weakness, and may be less specific, leading to higher estimates of the prevalence particularly for exhaustion, which was common in the SHARE population (9). In a follow-up on this

issue, Romero-Ortuno showed in detail how the categorization of study participants changed depending on how the five variables of the Fried Frailty Score were defined (24).

Differences due to different settings

The prevalence rates differ substantially depending on the setting where they have been conducted. Prevalence rates are substantially lower among community-dwelling individuals compared with institutionalized individuals living, e. g., in nursing homes. The review by Nguyen revealed a prevalence of frailty of 49% in institutionalized older patients in Brazil and 32% in hospitalized older patients in India. The prevalence of frailty in outpatient clinics was 55%-71% in Brazil and 28% in Peru (15). As mentioned above, this may also differ between countries or regions, depending, for example, on whether older people are more likely to stay at home or with family member rather than living at nursery homes. This leads to lower or higher proportions of frail elderly in the community-dwelling population (10).

**Risk factors**

A systematic review evaluated factors that were either risk or protective factors for frailty (25). In total, 23 longitudinal studies with community-dwelling individuals 60+ years old were included. Statistically significant associations with frailty were observed for sociodemographic factors (7/7 studies; this included older age, ethnic background, neighbourhood, and access to private insurance or Medicare), physical factors (5/6 studies; obesity and activities of daily living functional status), biological factors (5/7 studies; serum uric acid), lifestyle factors (11/13 studies; higher Diet Quality Index International score, higher fruit/vegetable consumption and higher tertile of all measures of habitual dietary resveratrol exposure), and psychological factors (7/8 studies; depressive symptoms). Many more factors have been analysed in these studies, but most of them either did not turn out to be significantly associated with frailty or were examined in only a small number of studies (25). The study among Australian aboriginal people clearly supports a multifactorial aetiology, including on the one hand underlying chronic diseases and on the other hand psychosocial stressors (20).

Age and sex seem to be clearly associated with frailty. In the meta-analysis by Collard et al., the prevalence increased with age and was higher in women (9.6%, 95% CI 9.2-10.0%) than in men (5.2%, 95% CI 4.9-5.5%) (2). In the SHARE survey, at all ages, the mean frailty index was greater in women than in men regardless of country. Every additional year of age was associated with a 3.5 and 2.8% higher mean frailty index in lower- and higher-income countries, respectively (10). The difference by sex and the increase with age are seen in high- (7) as well as in low- and middle-income countries (11). The prevalence of frailty is higher in women compared to men because women have lower average amounts of lean body mass and muscle strength (2).

A systematic review and meta-analysis by Verlaan et al. (26) assessed the prevalence of malnutrition and frailty among community-dwelling elderly, the prevalence of frailty ranged between 0% (a study in Taiwan) and 36.6% (in a Lebanese study). Pooling data from ten studies using comparable assessment instruments, the authors observed that the prevalence of physical frailty was higher among those with less favourable nutritional status such that 68.0% were frail in the malnourished group, but only 11.9% in the well-nourished group (as assessed using the Mini-Nutritional Assessment) (26). However, vice versa, the association was less clear. A prevalence rate of 0.5% malnutrition was observed in the robust group and 8.4% in the frail group.

## Frailty Progression

So far, only few studies examined the progression of frailty. Most studies are cross-sectional in nature and do not observe changes over time. However, frailty is not a steady state. In a follow-up of the SHARE study that included individuals 55+ years old, frailty worsened in 22.1% of the participants within two years after the first assessment, remained stable in 61.8% of the participants and improved in 16.1% (27). The risk of worsening increased with age and was statistically significantly higher in individuals 65+ years old at baseline assessment, in women and in individuals with low education. It is interesting that participants from Southern European countries (France, Italy and Greece) had an increased risk of worsening at an earlier age compared with those in Northern and middle European countries (Sweden, Denmark, Germany, the Netherlands, and Switzerland). Also, although

there was an overall higher risk among women for worsening of symptoms compared with men, no sex differences were found in Northern European countries, whereas women were at increased risk of worsening in frailty state compared with men in Southern European countries and in Belgium. A systematic review of three studies concluded that studies on frailty trajectories are rare and the results, as for prevalence and incidence rates, highly heterogeneous and dependent on the population and the setting (28).

## Conclusion

In summary, frailty is widely spread in the elderly population worldwide. Depending on the instrument that was used to determine frailty, the calculated prevalence will vary. Studies have shown that prevalence rates are more comparable when the physical frailty index as defined by Fried and colleagues is used than a broader definition that also covers social and psychosocial aspects. However, not only the instrument used, but also geographic variation has been observed independent of the assessment instrument. Prevalence rates in the community-dwelling population tend to be higher in lower-income countries compared with higher-income countries and one of the underlying reasons might be that in lower-income countries fewer older, and potentially frail, people live in nurseries than in higher-income countries. Contributing to differences between studies are different proportions of men and women and different age distributions. Other factors, such as nutritional status, depression, but also ethnic background, are important. Few studies have, however, been conducted on the progression of frailty. Although it has been shown that frailty status of individuals may improve, it is currently unclear who is more likely to improve and why.

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